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LABORATORY

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FY2009 Highlights A Tradition of Excellence Continues

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Disclaimer

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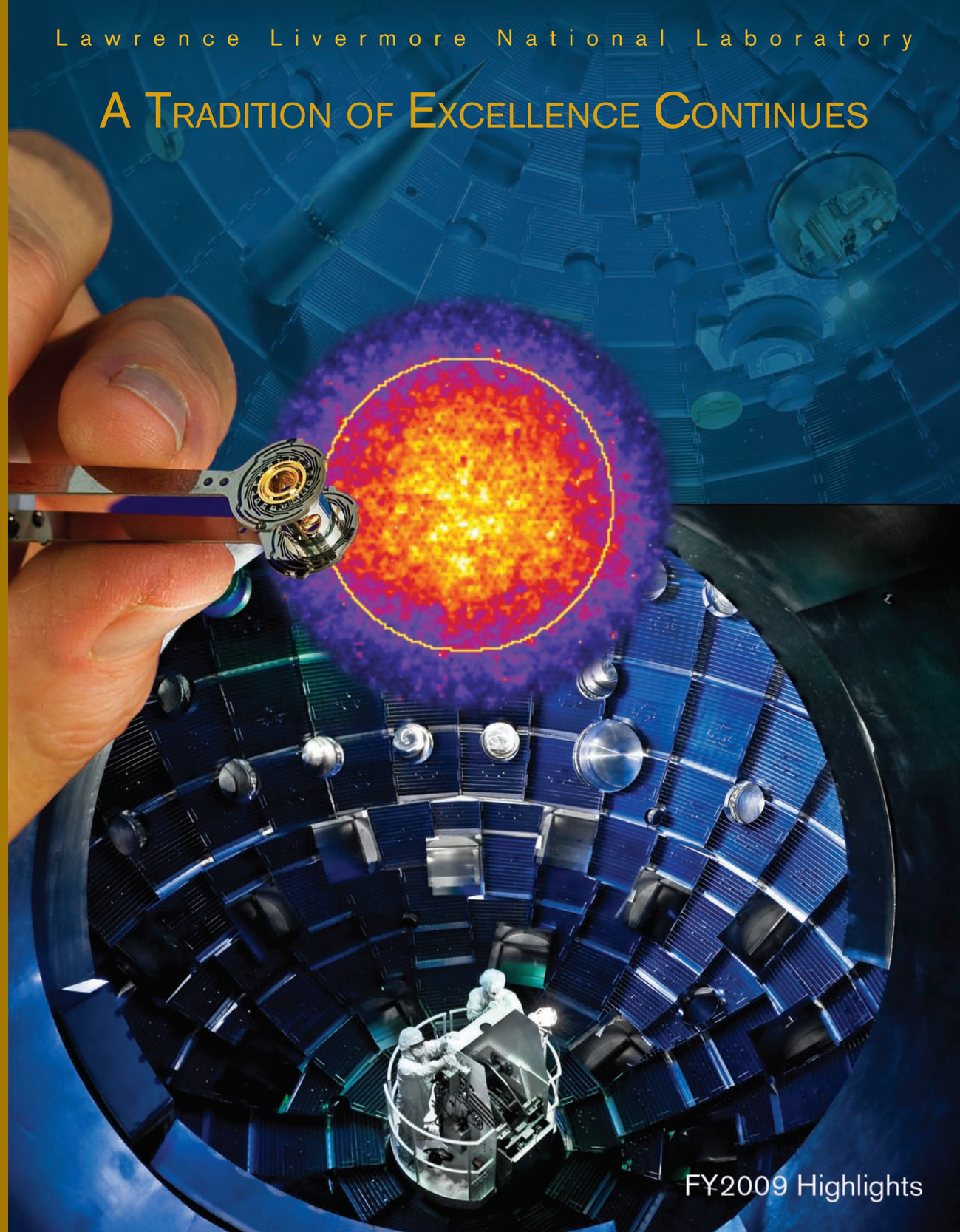
Lawrence Livermore National Laboratory

A Tradition of Excellence Continues



FY2009 Highlights

Managed by Lawrence Livermore National Security, LLC, for the
U.S. Department of Energy's National Nuclear Security Administration

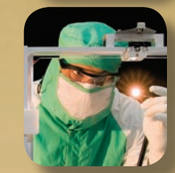
About the Cover

Technicians work inside the 10-meter-diameter target chamber of the National Ignition Facility (lower image). The 192-beam laser facility was formally dedicated on May 29, 2009. One of the gold-plated laser target hohlraums is shown at left, superimposed on an image of a symmetrical implosion obtained from an experiment in an ongoing campaign to achieve fusion ignition and energy gain for the first time in a laboratory setting.

About the Laboratory

Lawrence Livermore National Laboratory was founded in 1952 to enhance the security of the United States by advancing nuclear weapons science and technology. With our world-class scientific and technical capabilities, a talented and dedicated workforce, and a tradition of innovation and intellectual integrity, the Laboratory anticipates, develops, and delivers solutions to problems of national and global importance. The Laboratory is managed by Lawrence Livermore National Security, LLC, for the National Nuclear Security Administration within the U.S. Department of Energy.

Inside
The Year in Review 2009

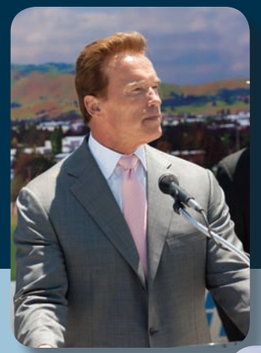







Director's Message

Achieving success under challenging conditions



George H. Miller
LLNL Director
LLNS President

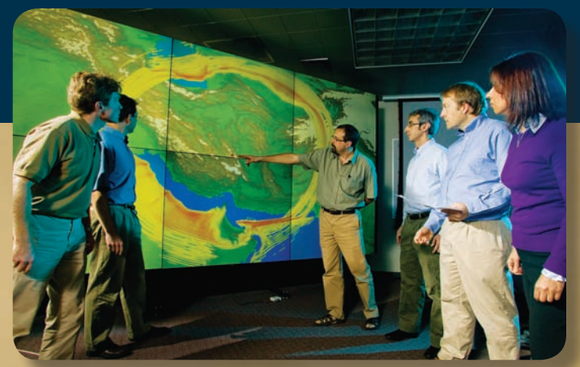
More than 3,500 guests attended the formal dedication of the National Ignition Facility, including California Governor Arnold Schwarzenegger (above) and Congressional Representative Ellen Tauscher (right), now Under Secretary of State for Arms Control and International Security.

The challenges facing the country are immense—health care and the economy, conflicts in Iraq and Afghanistan, threats of proliferation and terrorism, and looming energy and climate crises just to name a few. However, challenges like these are the reason the Lawrence Livermore National Laboratory (LLNL) exists, with our mission to apply scientific creativity and technical innovation to solve problems of national and global importance.

With the completion of the National Ignition Facility (NIF)—the largest project ever undertaken at the Laboratory—we are poised to resolve key issues about nuclear weapons performance, demonstrate the potential of fusion as a future source of clean energy, and provide insight into the very nature of the cosmos. Through these and other efforts, we are reducing the threat of nuclear proliferation and terrorism, devising carbon-neutral ways of using fossil fuels, advancing human health, and elucidating the intricacies of global climate change. Although our national security responsibilities are great, this is a dynamic and exciting time for the Laboratory.

The accomplishments highlighted in this annual report continue our half-century legacy of exceptional scientific achievement in service to the nation. Our work is carried out with relentless commitment to safety, security, fiscal responsibility, and efficiency. We are dedicated to sustaining the public's trust in our Laboratory, each and every day, through hard work, creativity, integrity, and the ability to take on and succeed at challenges that others regard as impossible.

2009 Highlights



Livermore seismologists developed improved three-dimensional models of seismic wave travel time, increasing the accuracy with which seismic events (e.g., nuclear explosions) can be located.

NIF Dedication

The Laboratory embarked on a new era of scientific inquiry with the May 29, 2009, dedication of NIF. It is the first laser facility to break the megajoule barrier, having delivered 1.1 megajoules of ultraviolet energy to the center of the target chamber. In addition, we successfully conducted NIF experiments relevant to stockpile stewardship and completed a series of shots aimed at understanding hohlraum energetics as part of the National Ignition Campaign.

Stockpile Stewardship

LLNL brought new scientific capabilities on board and added depth and rigor to the methodology and peer-review process that underpin the Annual Stockpile Assessment. The 500-teraflops Dawn supercomputer was delivered in February, and by April it was demonstrating groundbreaking science with some of the highest resolution, largest simulations ever run. The Laboratory also developed new technologies for the Pantex Plant and provided technical expertise for the Nuclear Posture Review.

National and Global Security

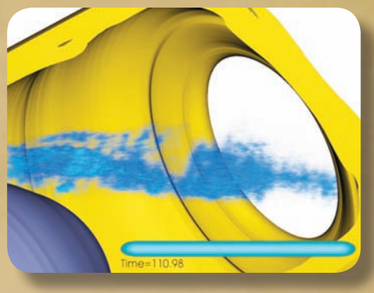
In support of nonproliferation and global threat reduction, LLNL delivered detection technologies and monitoring systems to sites worldwide and helped eliminate or secure at-risk nuclear materials in Russia, Africa, and elsewhere. Our world-class computational modeling capabilities were used to investigate promising approaches for capturing carbon dioxide from power plant emissions and for various issues of importance to the homeland security, defense, and intelligence communities.

Science and Technology Advances

LLNL continued its tradition of scientific discovery and technical innovation. We helped discover a new solar system and invented a technique for producing large quantities of antimatter in a laboratory setting. Researchers also created the first-ever bio-nano-electronic device with some of the critical features of nerve cells. We garnered a record eight R&D 100 Awards and launched new initiatives to promote the transfer of LLNL-developed technologies to the marketplace.

Strengthened Management and Operations

LLNL made improvements to its security posture, safety processes, and business systems, which were validated by outside audits and reviews. In the annual force-on-force exercise, our special response team successfully repelled an assault by the highly trained adversary team. We completed Phase I of our Integrated Safety Management System recertification and declared readiness for Phase II. In addition, an external review team noted that we made more progress over a two-year period than other Department of Energy (DOE) sites in implementing an effective Contractor Assurance System. Site footprint reduction efforts and the centralizing and streamlining of several business functions yielded roughly $25 million in annual cost savings.



The new Dawn supercomputer (left) generated some of the largest, highest-resolution simulations ever run, including simulations of laser–plasma interaction inside a NIF hohlraum (above).

Nuclear Deterrence

Ensuring the safety, security, and reliability of the enduring stockpile

LLNL's foremost responsibility as a national security laboratory is to ensure the safety, security, and reliability of the U.S. nuclear deterrent. Through experiments, theory, and simulations, our researchers investigate the fundamental science of nuclear weapons and understand the effects of aging on warhead materials and weapons performance. These results, validated against past nuclear test data, are used to assess the condition of stockpile weapons, develop modifications as needed, and certify the stockpile without nuclear tests. As a center of excellence for nuclear design and engineering and for high explosives research and development, we also pursue innovations to improve the efficiency and effectiveness of the nuclear weapons complex.

New scientific capabilities brought on board this year for stockpile stewardship include Hyperion (above), a collaboration with 10 computing industry leaders to advance next-generation high-performance computing clusters, and the Phoenix explosive pulsed-power experiments (right) for measuring material properties at extreme temperatures and pressures.

2009 Highlights

Researchers set up a detonator surveillance test inside one of the firing tanks at the High Explosives Applications Facility.

Annual Stockpile Assessment

The Laboratory completed Cycle 14 of the Annual Stockpile Assessment, making a number of improvements to enhance peer review and add depth and rigor to the process. We developed more consistent physics models that are applicable to all the weapons systems for which LLNL is responsible. In addition, this year's assessment of the W87 intercontinental ballistic missile warhead entailed a far more exhaustive application of the Quantification of Margins and Uncertainties methodology for evaluating weapons performance, which required a large number of high-resolution, full-physics simulations using some of the world's most capable supercomputers, located at LLNL.

The Dawn of Petascale Computing

A new 500-teraflops Advanced Simulation and Computing system, called Dawn, was delivered to LLNL in early 2009. By April, the machine was generating groundbreaking science; enhanced code performance; and some of the largest, highest-resolution simulations ever run. Dawn (an IBM BlueGene/P system) will lay the foundation for petascale computing on Sequoia, which will be the world's fastest supercomputer when it is delivered in 2011. With a peak speed of 20 petaflops (20 quadrillion floating-point operations per second), Sequoia will vastly enhance the predictive simulation capability needed to sustain the nation's nuclear stockpile without nuclear testing. In another project called Hyperion, we have teamed with 10 computing industry leaders to speed the development and reduce the cost of high-performance computing clusters. Hyperion will be used by LLNL and our partners to evaluate advanced system hardware and software concepts, and the experience gained will contribute to the success of Sequoia.

Stockpile Stewardship Experiments

LLNL conducted a range of tests in FY2009 to validate the science-based models used for stockpile stewardship. These tests included the first high-energy-density physics experiments at NIF, which returned excellent data. Hydrodynamics tests were conducted at our Contained Firing Facility (CFF), including the last in a series of experiments to help resolve a key weapons performance issue involving energy balance. Integrated weapons experiments at CFF also provided essential data for a Livermore weapons system model and for safety analyses by Los Alamos National Laboratory. At the Nevada Test Site, we successfully conducted the third and fourth Phoenix explosive pulsed-power tests. Phoenix aims to provide a greatly enhanced experimental capability for measuring material properties at extremely high pressures and densities.

New Capabilities for Pantex

Laboratory scientists and engineers developed and installed a new imaging technology called the Confined Large Optical Scintillator Screening and Imaging System (CoLOSSIS) at the Pantex Plant, the nation's facility for assembling and disassembling nuclear weapons. CoLOSSIS provides three-dimensional computed tomography X-ray images of warhead pits in unprecedented detail, reducing the need for destructive testing to assess the condition of these critical weapons components. We also led the Collaborative Authorization of the Safety Basis Total Lifecycle Environment (CASTLE) project to develop a software package for streamlining the processes that ensure safe operations at Pantex. CASTLE is currently being applied to several warhead dismantlement programs and to the life-extension program for the Los Alamos-designed W76 warhead.

Technical Support for Policy Options

In support of the Nuclear Posture Review that is currently under way, LLNL researchers furnished a spectrum of technical life-extension options for sustaining the U.S. nuclear deterrent over the coming decades with a reduced nuclear stockpile. We also contributed to the Obama administration's reevaluation of the Comprehensive Test Ban Treaty, leading a multilaboratory team that assessed the effectiveness and development status of the on-site inspection regime, an important element for ensuring compliance with the treaty.

Reduction of SNM Inventory

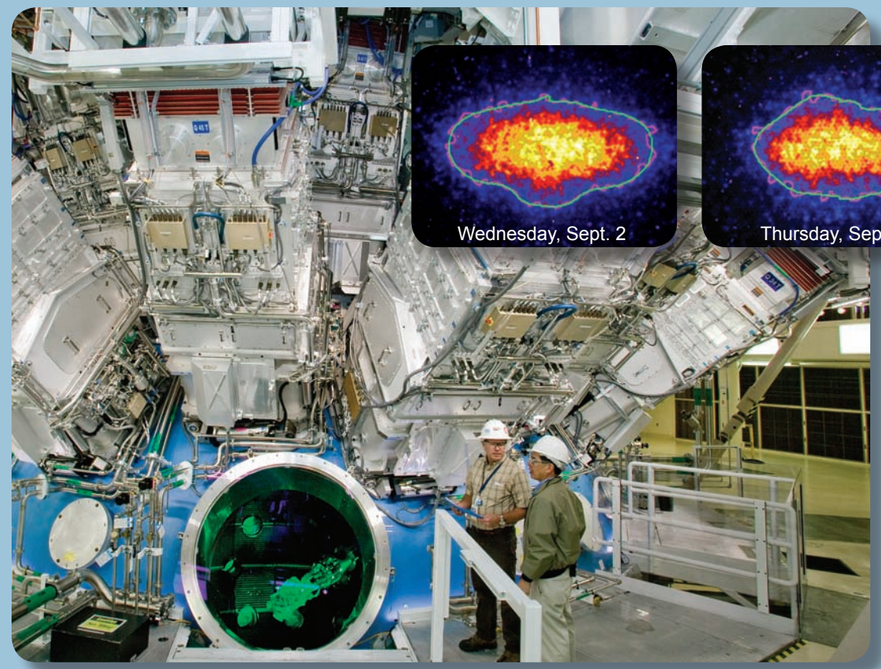
We exceeded the planned goals for removing special nuclear material (SNM) from LLNL that requires the highest level of protection. At the end of FY2009, more than two-thirds of the material had already been shipped to other sites as part of the National Nuclear Security Administration's (NNSA's) effort to consolidate SNM at only a few locations in the nuclear weapons complex. The deinventory, which began in October 2006, is on track to be completed in 2012.

National Ignition Facility

Completing the NIF project and beginning the campaign to achieve fusion ignition

NIF is the most energetic laser system in the world and the only facility capable of creating the conditions necessary for fusion ignition and burn in a laboratory setting. NIF epitomizes the kind of versatile "big science" that has been a hallmark of the Laboratory for more than 50 years. It is a critical experimental facility for stockpile stewardship and an important international scientific resource. Experiments at NIF will help resolve key issues about nuclear weapons performance; provide a unique experimental platform to study how materials behave under extreme temperatures and pressures; and demonstrate the potential of laser fusion as a clean, sustainable energy source for the future.

A technician examines a slab of laser glass for minute defects (above). National Ignition Facility engineers inspect the exterior of the target chamber (right). First results from hohlraum experiments demonstrated the use of "wavelength tuning" to adjust the shape of the implosion from asymmetric to spherical (inset images).



2009 Highlights

NIF Dedication

NIF was formally dedicated on May 29, 2009, exactly 12 years to the day after its groundbreaking. More than 3,500 guests attended the ceremony, including California Governor Arnold Schwarzenegger; California Senator Dianne Feinstein; local Congressional Representatives Ellen Tauscher, Jerry McNerney, and Zoe Lofgren as well as University of California President Mark Yudof; Lawrence Livermore National Security, LLC (LLNS) Board of Governors Chairman Norm Pattiz; DOE Under Secretary of Science Steve Koonin; and NNSA Administrator Tom D'Agostino. Charles Townes, the inventor of the laser, also attended, along with many former LLNL directors and laser and fusion leaders from around the world. The event attracted national media attention, with portions aired live on network television.

Two months earlier, on March 31, 2009, DOE certified the completion of the NIF construction project. At that occasion, D'Agostino stated, "Completion of NIF is a true milestone that will make America safer and energy independent by opening new avenues of scientific advancement and discovery."

Breaking the Megajoule Barrier

At 3:15 a.m. on March 10, 2009, NIF became the first laser facility in the world to break the megajoule barrier. The shot, which was designed to last only a few nanoseconds, delivered 1.1 megajoules of ultraviolet energy to the center of the target chamber. The energy and power balance met expectations, and the pulse shape precisely matched that required for ignition. NIF is systematically ramping up to deliver its design specification of 1.8 megajoules of ultraviolet energy.

Progress toward Ignition

Early results from the National Ignition Campaign (NIC) and the opportunity to tour NIF were highlights for the 600 researchers from around the world who attended the Sixth International Conference on Inertial Fusion Sciences and Applications, which was held in San Francisco in September 2009. By conference time, the first 11 experimental shots using 192 beams had been performed, all at an ultraviolet energy of approximately 500 kilojoules. The last four shots were fired into cryogenically cooled targets and provided excellent data; these were the first experiments with neutron yield.

One of the most talked-about conference presentations featured the first results from NIC hohlraum experiments in which a technique called "wavelength tuning" was used to greatly improve implosion symmetry. By changing only the wavelength of some of the laser beams, an initially asymmetric implosion with a "pancake" shape was formed into a spherical one. These results confirmed our prediction that the wavelength tuning technique would work. This prediction was based on the results of high-fidelity three-dimensional simulations of the complex laser–plasma interaction processes, which were published in *Physical Review Letters*.

LIFE for Future Energy Security

At the National Energy Summit and International Dialogue, which was held this September in Washington, D.C., Director George Miller asserted that given sufficient funding, a prototype Laser Inertial Fusion Engine (LIFE) power plant could be brought into operation within 15 years. LIFE builds on the anticipated achievement of fusion with NIF and holds considerable promise as a sustainable carbon-free source of energy. The LIFE baseline concept is a pure fusion machine. LIFE could also be developed as a fusion–fission combination to meet other missions, such as destroying excess weapons-grade materials or disposing of spent nuclear fuel from today's light-water reactors, while generating copious amounts of electrical energy.

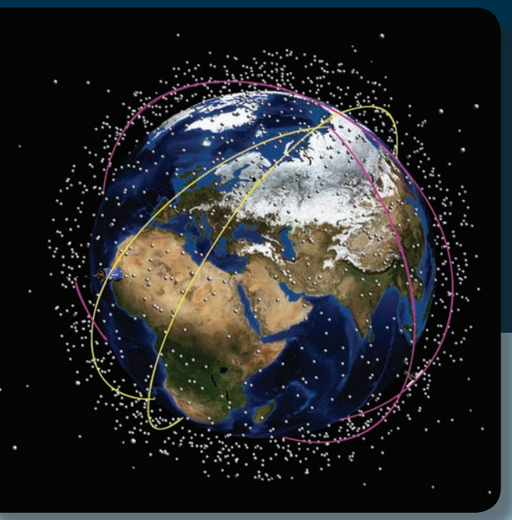
Creating a MEGaRAY

Laboratory researchers made important progress toward developing an intense, tunable source of mono-energetic gamma rays, called MEGaRAY. The concept is based on the interaction of a laser and an electron beam to generate a tunable laser beam-like photon source in the mega-electron-volt spectral range that is 15 orders of magnitude brighter than any other source. MEGaRAY efficiently excites the nucleus through a process called nuclear resonance fluorescence (NRF) that provides a unique fingerprint of the target's isotopic content. Similar to the way lasers have greatly advanced the study of atoms and molecules, this technology has the potential to revolutionize the study of the nucleus, creating applications in areas such as the detection of special nuclear material. In FY2009, we demonstrated the NRF technique for identifying a material using our first-generation tunable gamma-ray source and began development of an improved laser system for the next-generation MEGaRAY.

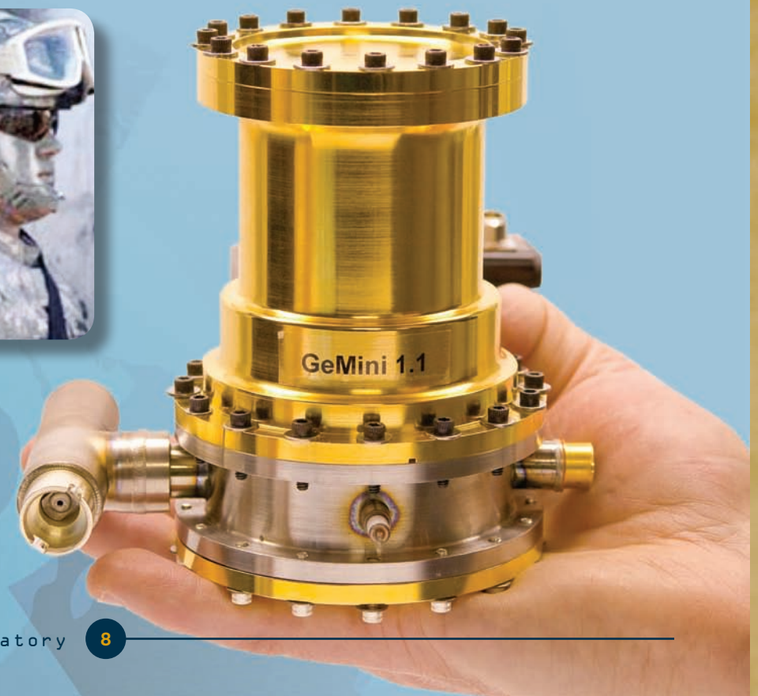
Global Security

Providing system solutions to counter WMD proliferation and terrorism and applying LLNL resources to ensure energy security and confront climate change

Global security is an enduring mission for the Laboratory. Our researchers apply the breadth and depth of LLNL's capabilities to reduce the threat posed by the proliferation, acquisition, or use of weapons of mass destruction (WMD) by nation-states or terrorists. Initiatives in cyber security and space situational awareness are under way to strengthen U.S. defenses in the information age. Recognizing that abundant energy and a sustainable environment are key to national security and global stability, we also work to develop clean energy technologies and to understand the mechanisms and implications of climate change, including the impact of human activities.



Computer models developed for a new space situational awareness initiative were used to analyze the debris resulting from the February 2009 collision of two communication satellites (above). Laboratory research revealed the mechanism by which nonlethal blast waves can cause traumatic brain injury (center). Our palm-size GeMini gamma-ray detector won a 2009 R&D 100 Award (right).



2009 Highlights

Seismic Detection of Nuclear Explosions
LLNL scientists spearheaded a multilaboratory team that developed a new tool for locating low-yield nuclear explosions. By incorporating three-dimensional variations in seismic wave speed in the earth's crust and lateral variability of seismic wave speed through the upper mantle, the Regional Seismic Transit Time (RSTT) model greatly increases the accuracy with which small seismic events, occurring halfway around the world, can be located (from 17.3 kilometers using a standard model to 9.3 kilometers using RSTT).

GeMini
Laboratory scientists and engineers developed GeMini, an ultralightweight, high-resolution gamma-ray spectrometer equipped with an innovative, low-power miniature cooling system. Carried on the MESSENGER spacecraft (launched in 2004), the palm-size detector is taking the first-ever gamma-ray data of the planet Mercury. GeMini instruments can also be used to help prevent nuclear smuggling and for international safeguards monitoring of nuclear facilities.

Recovery of Radioactive Sources
In the past year, Laboratory-led teams recovered a total of 77 radioisotopic thermoelectric generators from remote Russian coastal locations, where they were used to power lighthouses and navigation beacons. These devices typically contained one or more highly radioactive strontium-90 heat sources and, because they were largely unprotected, posed considerable nuclear safety and security concerns.

Blast Waves and Brain Injury
Research using LLNL-developed hydrodynamics codes revealed that nonlethal blast waves, such as those from a roadside bomb, can cause the skull to flex, resulting in traumatic brain injury even without direct head impact. Military combat personnel exposed to blast waves are at high risk for traumatic brain injury, and this research provides important information for better understanding these injuries and for developing improved helmet designs.

H1N1 Flu Predictions
Less than a week after the H1N1 influenza virus made headlines in March 2009, a team of Laboratory scientists used sophisticated data-mining techniques to compare specific nucleic-acid biomarkers in past pandemic influenza strains with the California strain of the H1N1 virus. They found that the H1N1 virus contains fewer than half the biomarkers for host adaptation and high mortality of the earlier influenza strains, leading them to predict that the winter 2009 H1N1 outbreak should be less severe than historical pandemics such as the 1918 Spanish flu.

NARAC 30th Anniversary
The National Atmospheric Release Advisory Center (NARAC), located at LLNL, celebrated its 30th anniversary. NARAC provides near-real-time predictions of the spread of hazardous materials released into the atmosphere (above). These predictions assist decision makers and emergency response personnel in managing such incidents to protect lives and mitigate safety, health, and environmental consequences.

Air Cargo Explosives Detection
The Air Cargo Explosive Detection Pilot Program, a three-year multilaboratory effort led by LLNL, was successfully completed. The goal of the program was to determine the requirements for large-scale screening of air cargo for explosive threats. The final report was submitted to Congress in January 2009 and included actionable recommendations for meeting the August 2010 requirement for screening 100 percent of cargo transported by passenger aircraft.

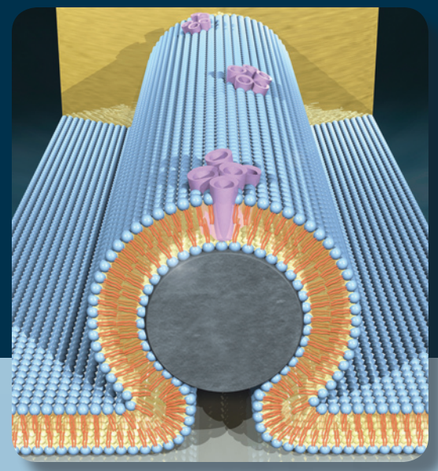
Ionic Liquids for Carbon Capture
Researchers identified a promising new class of materials that can be used to extract carbon dioxide from the flue gas of coal-fired power plants. Quantum-chemistry-based thermodynamic calculations indicate that ionic liquids (a special type of molten salt that is liquid at temperatures below the boiling point of water) have nearly double the carbon dioxide solubility and are much less corrosive and more chemically stable than the solvents currently used.

Effects of Climate Change
An LLNL scientist was the lead author of the opening chapter in *Global Climate Change Impacts in the United States*, the most comprehensive report to date on the probable national impacts of climate change. This definitive 190-page report describes how the country is already being influenced by climate change and how the nation's water, energy, transportation, agriculture, and health sectors will likely be affected in the future.

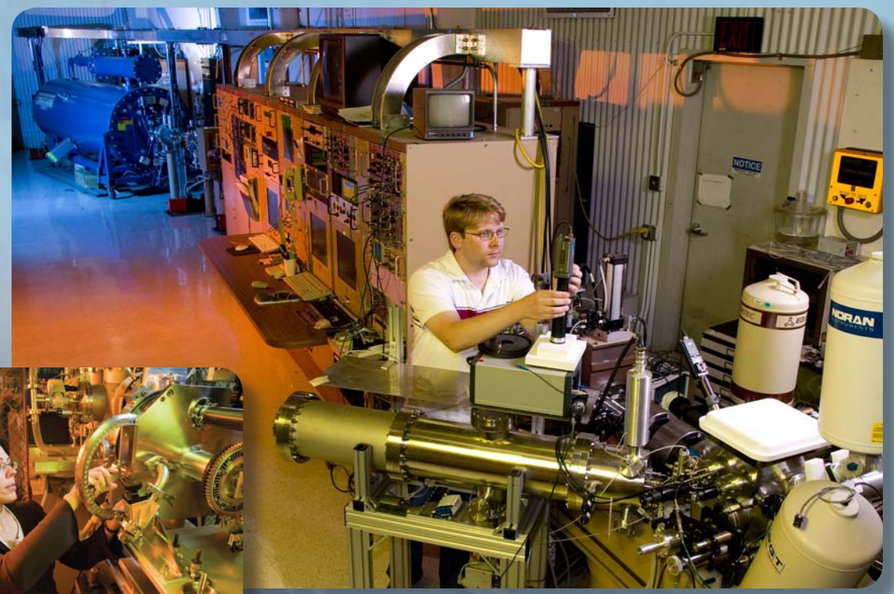
Science & Technology

Advancing the frontiers of science and technology and developing the capabilities to solve problems of national and global importance

Science and technology are the keys to overcoming many of the most serious challenges facing the nation and the world. LLNL harnesses its unique experimental facilities, world-class computing resources, and multidisciplinary expertise to investigate phenomena that are beyond the reach of other institutions and to solve problems that others regard as too difficult. We developed a five-year roadmap for science and technology investment to ensure the Laboratory's continued ability to make game-changing scientific discoveries and produce technical innovations for the future.



A bio-nano-electronic device that combines a silicon nanowire (grey) with a lipid bilayer (blue) could improve communication between prosthetic devices and the human body (above). At the Center for Accelerator Mass Spectrometry (CAMS), the most versatile and productive AMS facility in the world, scientists are making breakthroughs in biomedical and biodiversity research through ultrasensitive and precise carbon-14 measurements (right).



2009 Highlights

Using the Titan laser, Livermore scientists generated more antimatter particles, faster and in greater density, than ever before in a laboratory setting (above). The R&D 100 Award-winning artificial retina can be implanted into the eye to help restore sight to the blind (right).

New Solar System

LLNL was part of an international research team that captured the first-ever images of a multiplanet solar system. The newly discovered solar system orbits a dusty young star that is 140 light years away and about 1.5 times the size of our sun. It contains at least three giant planets that are roughly 10 times the mass of Jupiter. The images were taken using high-contrast, near-infrared adaptive optics on the Keck and Gemini telescopes. Because the planets can be imaged separately from their star, they can be studied individually using spectroscopy to gather data on their temperature, composition, and other properties. It appears that all three planets possess complex atmospheres with dusty clouds that partially trap and reradiate the escaping heat.

Nanowire "Nerves"

Livermore researchers developed a technique that enables nanowires to function like nerve cells, opening the door to improved communication between prosthetic devices and the human body. A silicon nanowire encased in a continuous lipid (fatty) membrane forms a barrier around the nanowire surface, creating a prototype bio-nano-electronic device that incorporates some features of a living system. By changing the gate voltage of the device, the transport of specific ions and small molecules across the membrane can be controlled, mimicking the way nerve cells function.

Antimatter Research

Using a short-pulse, ultraintense laser to irradiate a millimeter-thick gold target, Laboratory scientists produced more antimatter particles, faster and in greater density, than ever before in a laboratory setting. These experiments directly detected more than 1 million positrons (antielectrons), from which the scientists infer that approximately 100 billion positrons were produced in total. With this new technique, scientists will be able to study antimatter and perhaps gain clues as to why our universe contains more matter than antimatter.

Insight through CAMS

Carbon-14 measurements made at the Laboratory's Center for Accelerator Mass Spectrometry (CAMS) continued to yield surprising results for many different fields of inquiry. For example, in a finding with significant implications for heart attack recovery, CAMS data revealed that, contrary to popular belief, new human heart cells continue to develop into adulthood. For a 50-year-old person, roughly 55 percent of the heart's cells remain from the time around birth and 45 percent were generated at a later time.

R&D 100 and FLC Awards

Eight technologies developed by the Laboratory and research partners earned R&D 100 Awards. These "Oscars of Invention" were awarded for the palm-size GeMini gamma-ray spectrometer, an aerial land mine locator, the Femtoscope time microscope, a laser beam centering and pointing device, the Spectral Sentry system for protecting lasers from damage, a precision robotic assembly machine, the ROSE compiler infrastructure, and the first long-term artificial retina. We also received three Federal Laboratory Consortium (FLC) Awards for Excellence in Technology Transfer for a process that removes silica from geothermal waters, a pneumothorax detector, and a unique effort to strengthen U.S. maritime security.

New Mechanisms for Technology Transfer

LLNL initiated a number of new efforts to promote the transfer of Laboratory-developed technologies to the marketplace. For example, an innovative entrepreneurship program makes selected LLNL technologies available for business plan development by graduate students from Bay Area university business schools. Seven very promising business plans were received this year. A Stanford University team has formed a company and licensed a Laboratory flywheel energy storage technology and is making presentations to venture capitalists to launch the development of their product. Another team from the University of California at Davis placed second in that university's "Little Bang" competition for their business plan for LLNL's concept using carbon nanotubes for high-pressure hydrogen storage.

Industrial Partnerships

The Laboratory received 48 U.S. patents, filed 71 patent applications, and submitted 145 records of invention during FY2009. We also executed seven new cooperative research and development agreements with industry partners and signed 62 new commercial licenses for LLNL-developed technologies and software. Licensing and royalty income for the year topped $8 million, representing $300 million in annual sales of products based on Laboratory technologies.

Safety, Security, & Environment

Demonstrating safety and security excellence and responsible environmental stewardship in all Laboratory activities

LLNL has strengthened its collective commitment to safety, security, and the environment. Best practices are being implemented throughout the Laboratory, driven both from the top down and from the bottom up. We also draw upon the expertise of the LLNS partner organizations to identify opportunities for increasing effectiveness and reducing costs for safety, security, and environmental stewardship efforts.

To commemorate Earth Day 2009, the Laboratory dedicated its first "green facility," Building 264, to be certified under the Leadership in Energy and Environmental Design (LEED™) Green Building Rating System for existing buildings, developed by the U.S. Green Building Council (top). LLNL strengthened its efforts to integrate best practices in environment, safety, and health into all research activities, business and operations, and personal recreation (above). As an example, LLNL provided free bike helmets to employees through a new Bicycle Safety Program (right).

2009 Highlights

Protective Force Officers won third place in the annual U.S. National Special Weapons and Tactics (SWAT) Championships.

Emergency Readiness

The Laboratory took significant steps to increase our readiness in the event of an emergency. We completed a multiyear initiative to adopt California's Standardized Emergency Management System and link it with the National Incident Management System. Upgrades to the LLNL Emergency Plan were tested in the 2009 Shaker site-wide earthquake preparedness drill. This and other exercises served to verify the effectiveness of our emergency response procedures, policies, and training.

Security Improvements

The annual review by the DOE Office of Health, Safety, and Security confirmed the Laboratory's strengthened security posture. Over the past year, we made notable improvements in physical security, protective force, classified material protection, cyber security, and program management. In the yearly force-on-force exercise, our special response team quickly repelled an assault by an adversary team made up of highly trained security officers from across the DOE complex. This LLNL team also placed third at the annual U.S. National Special Weapons and Tactics (SWAT) Championships.

"Green" Initiatives

The Laboratory's approach to environmental stewardship was validated in September when our Environmental Management System received recommendation for ISO 14001 registration. In addition, we exceeded our FY2009 goals for both energy and water conservation. Energy use is now nearly 14 percent below a 2003 baseline. The Terascale Simulation Facility alone achieved an estimated $2.4 million in annual energy savings by raising the building temperature a few degrees (without affecting machine reliability) and better managing the airflows that cool the computers. For water conservation, we converted more than 10,000 square feet of high-water-use landscaping to drought-tolerant plantings and completed a Water Conservation Test Bed that features rainwater harvesting into underground storage tanks (below).

Enhanced Safety

We augmented our strong commitment to safety with concerted efforts to improve our Integrated Safety Management System (ISMS). Phase I of ISMS recertification was completed in May, and in September we declared readiness for Phase II of this formal evaluation of the effectiveness of LLNL's processes for integrating environment, safety, and health requirements into work planning and controls. The Laboratory's overall safety performance improved in FY2009, surpassing goals for decreasing our total recordable cases (1.91 versus the 2.07 goal) and the days-away case rate (0.26 versus the 0.40 goal). Following an unlikely set of circumstances that led to a tragic on-site vehicular fatality, we launched a broad initiative to improve traffic safety at the Laboratory.

Attention to Occupational Health

LLNL implemented comprehensive programs in industrial hygiene and chronic beryllium disease prevention. To determine the current levels of beryllium contamination likely to be encountered during routine operations at the Laboratory, we conducted a comprehensive inventory and facility characterization survey. We also established a Beryllium Medical Surveillance Program and completed more than 65 percent of the actions identified to further reduce potential beryllium exposure to employees.

Environmental Protection

As documented in our annual Environmental Impact Report, we determined through environmental monitoring that operations at the Laboratory had no adverse impact on public health or the environment. After a shortfall in funding last year, we successfully met an aggressive schedule, established in March, to restart groundwater and soil vapor treatment operations on site. The effectiveness of LLNL-developed treatment technologies was convincingly demonstrated at the Southern California Edison utility pole yard in Visalia, California, where they were used to clean up the site 100 years faster than expected. On September 25, 2009, the pole yard became the first Superfund site to be removed from the Superfund list.

Management & Operations

Improving work processes, streamlining and standardizing business practices, and achieving cost efficiencies in operations

The Laboratory is committed to excellence in management, business, and operations. A number of initiatives have been launched to standardize work processes, eliminate duplications, and apply value-adding tools for managing work. We leverage the expertise of the LLNS partner organizations to identify opportunities for improving the efficiency and cost effectiveness of our operations.

U-Learn, LLNL's online learning center, offers a wide array of resources for employees to improve their skills at work or from home (above). Livermore's Six Sigma Black Belts are leading the continuous improvement effort for enhancing the efficiency and effectiveness of work processes (right). Site footprint reduction activities have resulted in the closure of nearly a million square feet of space since FY2008 (below).

2009 Highlights

Mail services is one of several operations that will be shared between Livermore and Sandia/California as part of the "One Site, Two Labs," effort.

Training for Future Leaders

In May 2009, the inaugural class of eight employees completed the LLNL National Security Leadership Program. The yearlong program is conducted by the Bush School of Government and Public Service at Texas A&M University. We also worked with the Haas School of Business at the University of California at Berkeley to design a new Leadership Development Program. This one-year program aims to build a cadre of skilled future leaders with common learning experience and vision for the Laboratory. The first class of 42 employees began in October 2009.

Moving forward with CAS

We made excellent progress in implementing the Contractor Assurance System (CAS) to provide assurance that we are meeting our performance objectives. CAS is an integrated system of tools and processes for managing requirements and standards, tracking issues and their resolution, collecting performance data, and continuously improving the assessment process. An external review team recently concluded that LLNL has made more progress in implementing basic CAS tools over a two-year period than other DOE sites.

Financial and Project Management

LLNL developed the foundation for a Laboratory-wide budget performance system based on the components of the Earned Value Management System (EVMS), a best-practices approach to tracking project performance. We purchased commercial off-the-shelf software and developed numerous business tools to implement and maintain the baseline system. In particular, we developed several new EVMS building blocks specific to LLNL, including a multilevel institution-wide work breakdown structure and a "code of accounts" that will clarify how much money is being spent in areas that are common across the institution, such as information technology.

Site Footprint Reduction

The Laboratory made excellent progress toward the goal of reducing the site footprint by 2 million square feet by FY2011. We have shut down or demolished more than 875,000 square feet of space since the initiative began in FY2008. In spite of limited funds, we exceeded this year's goal through careful planning, coordination, and attention to project execution. We achieved roughly $19 million in annual cost savings and $50 million in one-time cost avoidance for deferred maintenance and seismic upgrades.

Cost Savings through Enhanced Efficiency

The Laboratory achieved savings of approximately $5.2 million per year by centralizing and streamlining responsibility for the acquisition, receipt, and distribution of supplies and services. For example, this year our Procurement Services Deparment processed 10 percent more transactions at an 18-percent lower operating cost. We also consolidated and centralized information technology services such as the management of desktop applications and unclassified networks. As part of this effort, more than 200 servers from 18 different facilities were consolidated into the LLNL Data Center, saving about $1 million annually.

One Site, Two Labs

A joint LLNL–Sandia/California project team analyzed operational and infrastructure activities and identified a number of functions where shared operations would yield cost savings and efficiencies for both laboratories. Joint operations will begin in FY2010 for selected activities ranging from mail services and shipping and receiving to various technical information production services.

Reachback to LLNS Partners

The LLNS Board of Governors and its committees provided oversight to the Laboratory in critical areas related to mission and mission support. LLNS partner organizations furnished expertise in the form of 17 Functional Management Reviews on topics ranging from supply chain management to work for others. In some cases, the reviews resulted in LLNL adopting new technologies and importing commercial best practices; in other cases, they validated the effectiveness and successful application of new processes and procedures.

Workforce

Recognizing outstanding performance and accomplishments

Meeting the challenges of our mission requires a workforce of exceptionally talented, skilled, and dedicated employees. The many honors and awards received by Laboratory employees are a testament to the excellence of our researchers, the technologies they develop, their contributions to their professions, and their impact on the security and competitiveness of the nation.

Laboratory researchers received two of the most prestigious awards in the world of science. The National Medal of Science was bestowed by President Obama upon Berni Alder, founder of the field of molecular dynamics and a key developer of the Monte Carlo method for computational modeling (above). The Edward Teller Medal was awarded jointly to LLNL's Ed Moses (in blue) and the University of Rochester's Riccardo Betti (in white) for their research contributions and leadership in laser fusion science.

2009 Highlights

National Medal of Science
Retired LLNL physicist and computational pioneer Berni Alder received the National Medal of Science, the highest honor bestowed by the U.S. government on scientists, engineers, and inventors. Alder is widely regarded as one of the creators of the Monte Carlo method of computer simulation. He was also inducted into the American Academy of Arts and Sciences.

Edward Teller Medal
The 2009 Edward Teller Medal was awarded to Ed Moses of LLNL and Riccardo Betti of the University of Rochester. The American Nuclear Society bestows the medal on individuals for pioneering research and leadership in inertial fusion science and applications.

Will Allis Prize
Theoretical physicist (retired) Ken Kulander received the 2008 Will Allis Prize from the American Physical Society in recognition of a career of contributions to the study of ionized gases.

Presidential Recognition
Environmental scientist Ellen Raber and physiologist Bob Kirvel were recognized by the Office of the President of the United States for their contributions to the content and production of the joint Department of Homeland Security–Environmental Protection Agency publication *Planning Guidance for Recovery following Biological Incidents*.

Exceptional Service Award
Fred Mackie, proliferation analyst (retired), was honored with the DOE Secretary's Exceptional Service Award in recognition of his three decades of leadership and insightful analyses of nuclear proliferation developments in South Asia.

2008 EMS Award
Molecular biologist Larry Thompson received the 2008 Environmental Mutagen Society (EMS) Award for his 35 years of research on mutagenesis and the biological processes by which cells repair DNA damage.

Federal 100 List
Mark Seager was named to the "Federal 100" list by *Federal Computer Week* magazine as one of the top executives from government, industry, and academia who had the greatest impact on government information systems. He was recognized for his leadership of the Hyperion Project, a collaboration with 10 industry leaders to advance next-generation Linux high-performance computing clusters.

Hall of Fame
Gina Bonanno, NIF program manager and leader of the National Ignition Campaign was inducted into the Alameda County Women's Hall of Fame (above). She is the seventh Laboratory scientist to receive this honor.

Fellows
Andy MacKinnon and Per Soderlind were named fellows of the American Physical Society. Don Correll and Ed Moses were elected fellows of the American Association for the Advancement of Science. Rick Ryerson was named a fellow of the American Geophysical Union. Keith Carlisle was elected a fellow of the Institute of Mechanical Engineers.

Awards of Excellence
Two individual LLNL researchers and seven Laboratory teams were presented with Weapons Awards of Excellence from NNSA for outstanding contributions to the nation's nuclear weapons program.

Fulbright Scholarships
Seismologist Artie Rodgers received a Fulbright Scholarship to the Laboratoire de Geophysique Interne et Technophysique in Grenoble, France, to study the relationship between topography and seismology. Computer scientist Panayot Vassilevski was awarded a Fulbright Scholarship to teach graduate-level computational mathematics at the St. Kliment Ohridski University of Sofia, Bulgaria.

Outstanding Alumni
Randy Pico was honored as one of DeVry University's "Most Distinguished Alumni." Pico is the primary architect of a relationship between LLNL and the university that has brought numerous DeVry technical graduates to the Laboratory.

Postdocs and Scholars
LLNL hosted more than 100 postdoctoral fellows and approximately 300 students and faculty for research opportunities at the Laboratory. These programs give outstanding young scientists and teachers valuable experience in national security-related research and help improve science education. The postdoc program also serves as a way to attract top talent to the Laboratory. In FY2009, 40 postdoctoral fellows joined the Laboratory as new employees.

Community Connections

Contributing to local communities through science and math outreach and charitable giving

LLNL is a valued and contributing member of the community, with a particular emphasis on outreach in science, engineering, and mathematics education. Laboratory employees also generously support local communities through volunteer efforts and charitable giving. In addition, the LLNS gift program provides a direct investment in community science and math education and the cultural arts.

More than 14,000 people, including employees, their families, and guests, attended Family Days Open House, where they toured the National Ignition Facility and other Laboratory facilities; transportation around the site was provided by cable car-style trolleys on wheels (above photos). During the FY2009 HOME campaign, employees donated food items to the Open Heart Kitchen as part of a site-wide canned food drive (right).

2009 Highlights

Family Days Open House
On the last weekend in May, we hosted the first open house for Laboratory employees, their family members, and guests in nearly seven years. A total of 14,435 people attended the two-day event.

Open Campus Concept
We received NNSA approval for the Livermore Valley Open Campus concept. The proposed LLNL–Sandia/California joint venture would create a shared space between the two adjacent laboratories to promote collaboration with industry and academia and help establish the Livermore Valley as a high-tech center in the East Bay.

Partnership with the Army Reserve
LLNL signed a memorandum of agreement with the U.S. Army Reserve to participate in the Northern California Employer Partnership Initiative. The agreement gives the Laboratory access to skilled Army Reserve soldiers as potential employees and provides soldiers increased job opportunities with a community employer.

Science on Saturday
LLNL's "Science on Saturday" lectures played to packed houses in FY2009. A record 7,725 people attended the events, which were held in Livermore, Tracy, and Hayward. Laboratory researchers partnered with local science teachers to present science discussions and demonstrations on wind power, aerogel materials, fusion energy, biosecurity, light-based communications, the origin of the solar system, and options for diverting asteroids.

Science and Engineering Fair
The 13th annual Tri-Valley Science and Engineering Fair, sponsored by LLNL, featured 180 projects by 249 middle- and high-school students from area school districts. More than 90 local scientists and engineers served as judges, including nearly 70 from the Laboratory. One high-school winner received multiple awards at the Intel International Science and Engineering Fair, including a full-tuition college scholarship. Two of the middle-school winners went on to earn awards at the California State Science Fair.

Science Education Support
Four graduating high-school seniors (two from Livermore and two from Tracy) who excelled in science studies were awarded $1,500 Edward Teller Science Scholarships toward their college education. More than 100 teachers took part in summer Teacher Research Academies at LLNL, where they learned new ways to bring science into the classroom. In addition, 22 teachers and 10 college students preparing for science-teaching careers participated in mentored summer research at the Laboratory.

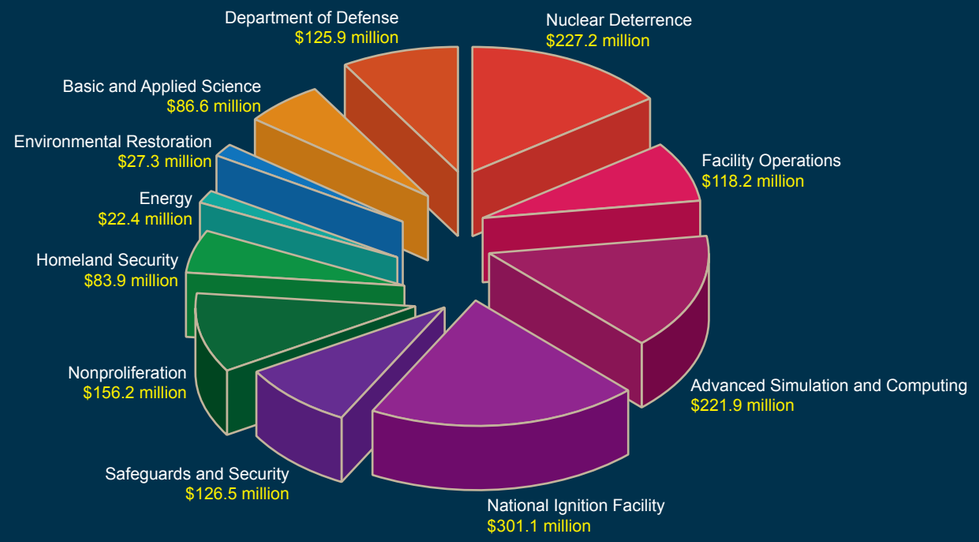
(Clockwise from top left) LLNL received an award of appreciation from the American Red Cross, joined with the U.S. Army Reserve in an employer partnership initiative, and sponsored the 13th annual Tri-Valley Science and Engineering Fair.

Blood Donations
LLNL received the President's Volunteer Service Award from the Northern California Blood Services Division of the American Red Cross. The Laboratory has sponsored blood drives for more than 25 years and is the largest corporate sponsor for the American Red Cross Northern California Region. LLNL employees have donated more than 18,000 units of blood over the years, including over 700 units in the past year alone.

Annual HOME Campaign
Laboratory employees donated more than $1.6 million to community and nonprofit organizations in the Tri-Valley, San Joaquin Valley, and the greater San Francisco Bay Area through our annual Helping Others More Effectively (HOME) campaign. With the LLNS matching donation of $1 million, the total HOME contribution surpassed $2.6 million.

Facts & Figures

LLNL FY2009 Actual Costs: $1.497 billion



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FY2009 Accomplishments "By the Numbers"

Completed Cycle 14 of the Annual Stockpile Assessment.

Received and installed the 500-teraflops Dawn BlueGene/P supercomputer, which is currently ranked ninth on the Top500 list of supercomputers.

Removed more than 67 percent of SNM from the Livermore site (as of October 2006 inventory levels).

Dedicated NIF 12 years to the day after the facility's groundbreaking.

Delivered 1.1 megajoules of ultraviolet energy to the center of the NIF target chamber, becoming the first laser facility in the world to break the megajoule barrier.

Recovered 77 radioisotopic thermonuclear generators from remote regions of the Russian coastline.

Celebrated NARAC's 30th anniversary.
Received one National Medal of Science, one Edward Teller Medal, one Will Allis Prize, and nine Weapons Awards of Excellence.

Captured the first images of a newly discovered solar system containing at least three giant planets.

Created an estimated 100 billion antimatter particles in a single laboratory experiment.

Developed a five-year roadmap for the Laboratory's science and technology investment strategy.

Garnered eight R&D 100 Awards and three FLC Awards for Excellence in Technology Transfer.

Received 48 patents, filed 71 patent applications, and submitted 145 records of invention.

Executed eight new cooperative research and development agreements and signed 62 new commercial licenses.

Generated $8 million in royalty and licensing income, representing $300 million in sales of products based on LLNL technologies.

Earned $4.35 in royalty and licensing income for every dollar invested in industrial partnerships.

Won third place in the U.S. SWAT Championships.

Received recommendation for ISO 14001 registration of the Laboratory's Environmental Management System.

Became the first site in the DOE complex to earn a "green building" certification.

Achieved more than $6 million in annual cost savings by centralizing supply chain management and information technology services.

Reduced energy usage by 13.7 percent compared to the FY2003 baseline and decreased water usage by 6.6 percent compared to the FY2007 baseline.

Closed more than 875,000 gross square feet of space since FY2007, for a savings of roughly $19 million in annual costs and $50 million in one-time cost avoidance.

Welcomed 14,435 people, including employees, their family members, and guests, to the Laboratory's Family Days Open House.

Hosted more than 100 postdoctoral fellows and roughly 300 students and faculty for research opportunities at the Laboratory.

Sponsored the 13th annual Tri-Valley Science and Engineering Fair for local middle- and high-school students.

Delivered eight Science on Saturday lectures, with multiple sessions for each presentation, to a total audience of 7,725 people.

Donated more than 700 units of blood for the American Red Cross.

Donated more than $2.6 million through the annual HOME campaign, including $1 million in matching funds from LLNS.